Physicochemical characterisation of nucleation mode particles observed at a remote coastal site (Agnes Water) on the east coast of Australia

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Keywords: Marine aerosols, nucleation, aerosol characterisation, VHTDMA.

Coastal and marine particle nucleation events have been observed to occur frequently around the world. For example very large particle formation events are observed frequently at Mace Head (Ireland) during low tides and periods of high solar irradiance. These events have been linked to the emission of iodine-containing compounds from exposed biota (O'Dowd *et al.*, 2002). It is not entirely clear whether iodine-containing compounds are involved in nucleation events at other coastal sites around the world or whether other compounds such as sulphuric acid, most likely formed from the oxidation of di-methyl sulphide (DMS), is the compound responsible for nucleation.

Here we report the observation and physicochemical characterisation of nucleation mode particles at Agnes Water ($24^0$12'S, $151^0$54'E) a remote coastal site ~500km north of Brisbane on the east coast of Australia. The southernmost reefs of the Great Barrier Reef (GBR) lie ~50km north east of the sampling point. A suite of instruments including an Air Ion Spectrometer (AIS), SMPS, meteorological instruments and a Volatility Hygroscopic Tandem Differential Mobility Analyser (VHTDMA) were employed during the campaign conducted over a month in autumn (March/April) 2007. The VHTDMA is capable of simultaneously measuring with high time resolution the volatility and hygroscopic properties of particles as small as 7nm. It therefore places significant constraints on the possible composition and structure of nucleation mode particles. A full VHTDMA characterisation, where the hygroscopic growth factor is measured at each volatilisation temperature, normally takes 40-150 minutes to complete.

Two types of nucleation events were observed throughout the campaign depending on the wind direction. One type of nucleation event occurred under conditions of high solar irradiance when the south east trade winds were blowing and was not related to tide. This type of event was most common (12 occurrences) as the SE trade winds blew on all days except one during the campaign. Back trajectory analysis showed that these events occurred in air masses that had spent at least 4 days travelling over the open ocean. Full VHTDMA characterisations of nucleation mode particles were completed during two of these events. An example of a VHTDMA characterisation of 16nm particles completed on 27-03-07 is shown in Figure 1. Based on comparisons with laboratory generated aerosols the volatility curve suggests these particles contained a SOA coating (evaporating from 40-100^0C) over an ammoniated sulphate core (evaporating from 120-180^{o}C). The hygroscopic growth factor (HGF) measurements at 90% RH support this hypothesis. At room temperature the particles had a HGF of ~1.3. As the particles were heated and the SOA coating evaporated, HGF increased to ~1.5, which is consistent with the hygroscopic growth of sulphates. More than half of this type of nucleation event appeared to occur locally in the MBL. The rest were observed in entrained air from the free troposphere suggesting the sulphate particle nucleation may have occurred aloft.

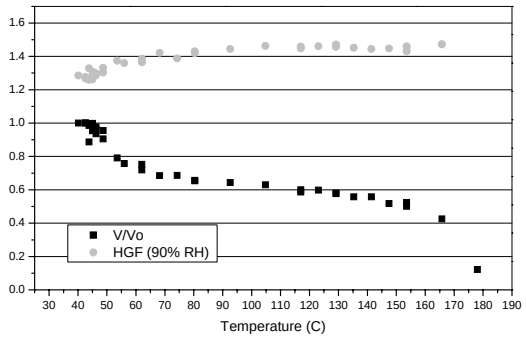

Figure 1: VHTDMA characterisation of 16nm nucleation mode particles: V/Vo- Volume fraction remaining, HGF-Hygroscopic growth factor at 90% RH

A second type of nucleation event was observed on one occasion on the morning of 30-03-07 when winds were coming from the north and the air masses were crossing the GBR. Measurements of the HGF conducted at 90% RH and 117^{o}C volatilisation temperature suggest that these particles were also SOA coated sulphates. Previous literature (Broadbent and Jones, 2004) identifies the GBR as a large source of DMS from which these nucleation particles could originate.

O'Dowd C.D., Jimenez J. L. *et al* (2002). *Nature*, 417, 632-636.

Broadbent, A. D., & Jones, G. B. (2004). *Marine and Freshwater Research 55*, 849-855.